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METHOD FOR MANUFACTURING HEAT EXCHANGING ELEMENT  
[NETSUKOKAN SOSHI NO SEIZO HOHO]

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1. Title of the Invention

Method for Manufacturing Heat Exchanging Element

2. Claim(s)

(1) A method for manufacturing a heat exchanging element in which manufacture comprises a molding step in which fin-shaped ribs constituting parallel flow passes through which a hot medium passes are provided on one side of a flat plate-shaped plate comprising a piece of paper or the like, and unit members in which the same ribs are arranged on the reverse side at a right angle to the surface are subjected to continuous molding inside an injecting molding mold, a cutting step in which the continuous molded product of the above-mentioned unit members is cut into one unit member, an adhesive coating step in which the upper surfaces of the ribs of the above-mentioned unit members are coated with an adhesive, an insertion step in which a cut plate comprising paper or the like cut to a fixed dimension is inserted between the above-mentioned unit members, and a lamination step in which the respective unit members are laminated so that the aforesaid parallel flow passes are formed alternately.

(2) A method for manufacturing a heat exchanging element in which manufacture comprises a molding step in which fin-shaped ribs are provided on both sides of a flat plate-shaped plate, such as a piece of paper, the height of the ribs of the unit members formed by intersecting the parallel flow passes is halved, and continuous molding is done in an injection

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molding mold, a cutting step in which a continuous molded compact of the above-mentioned unit members is cut into one unit member, an adhesive coating step in which the upper sides of the ribs of the above-mentioned unit members are coated with an adhesive, and a lamination step in which the respective unit members are adhered and laminated to each other in the same direction by repeatedly turning them 90°.

(3) A method for manufacturing a heat exchanging element in which manufacture is comprised by inserting a required number of laminated cut plates of pieces of paper or the like which have been cut to fixed dimensions into a cast molding mold, cast molding a two-pack thermosetting resin, forming fin-shaped ribs which form parallel flow passes on both sides of the aforesaid plate, and at the same time, integrally molding them into a laminated state.

### 3. Detailed Specifications

#### Field of Industrial Application

The present invention relates to a method for manufacturing a plate fin-type heat exchanging element which is a laminated structure.

#### Prior Art

The heat transfer surface area per unit volume of plate fin-type heat exchanging elements is wide, which are used widely as relatively small, highly efficient heat exchanging elements. They can be classified as perpendicularly intersecting current types, counter current types, /598 and orthogonal current types (including orthogonal and diagonal) according to the different directions of flow of two-pack liquids to be heat exchanged, but the counter current and perpendicularly intersecting current types

are often employed in air-conditioning equipment. The basic configuration of such a conventional heat exchanging element was shown in the publication of Tokko No. 47-19990, for example. This configuration will now be described in reference to Figs. 11 and 12. As shown in the drawings, a heat exchanging element was formed by laminating a plate 101, which partitions a two-pack liquid to be heat exchanged, on both sides of corrugated fins 102 composing a plurality of rows of parallel flow passes. Although the heat exchanging element was manufactured by forming the aforesaid plate 101 from processed paper, whose base is a paper having combined heat transfer property and moisture permeability, corrugating the fins 102 from the same paper as the plate 101 and preparing unit members 103 composed of the plate 101 and the fins 102 in advance, and laminating a plurality of these unit members 103 so that the parallel flow passes are orthogonal to each other, the productivity was not very high and the heat exchanging element was high in cost.

Therefore, in order to enable an improvement in performance as well as productivity, the heat exchanger shown in the publication of Tokkai No. 61-186765) was developed. Its configuration will now be described in reference to Figs. 13 and 14. As shown in the drawings, it was manufactured by making the members corresponding to the fins rod-shaped or cord-shaped ribs 202 made of a nonmetallic material having good bondability to a plate 201, arranging the ribs 202 formed at any given height and pitch on the plate 201 with good precision to form unit members 203, as shown in Fig. 14, and coating the end faces opposite the plate 201 sides of the ribs

202 with an adhesive to laminate and join the respective unit members 203.

#### Problems to Be Solved by the Invention

In the method for manufacturing this kind of conventional heat exchanging element, there were problems when the unit members 203 were manufactured and laminating the unit members 203 because the relative difficulty of precision was high, a defective product was easily produced, and productivity could not improved very much.

Therefore, in the unit member manufacturing step, shortening of the molding step and improvement in precision is demanded, and in the lamination step, a method enabling joining by reliable positioning is demanded.

The present invention solves the above-mentioned problems and satisfies the above-mentioned demands, and it is an object thereof to provide a method for manufacturing a heat exchanging element with outstanding productivity wherein improvement of the performance of a heat exchanging element is engineered.

#### Means for Solving the Problems

In order to achieve the above-mentioned object, the 1<sup>st</sup> means of the present invention is a method of manufacture via a molding step in which fin-shaped ribs constituting parallel flow passes through which a hot medium passes are provided on one side of a flat plate-shaped piece of paper, and unit members in which the same ribs are arranged on the reverse side at a right angle to the surface are subjected to continuous molding inside an injecting molding mold, a cutting step in which the continuous

molded product of the above-mentioned unit members is cut into one unit member, an adhesive coating step in which the upper surfaces of the ribs of the above-mentioned unit members are coated with an adhesive, and a lamination step in which a piece of paper cut to fixed dimensions is inserted between the above-mentioned unit members, and the respective unit members are adhered and laminated in the same direction.

The 2<sup>nd</sup> means is a method of manufacture via, as a modified type of 1<sup>st</sup> means, a molding step in which the height of the fins of the 1<sup>st</sup> unit members is halved on both the surface and the reverse side, and continuous molding is done in an injection molding mold, a cutting step in which a continuous molded compact of the above-mentioned unit members is cut into one unit member, an adhesive coating step in which the upper sides of the ribs of the above-mentioned unit members are coated with an adhesive, and a lamination step in which the respective unit members are adhered and laminated by repeatedly turning them 90°.

Furthermore, as the 3<sup>rd</sup> means, in order to achieve both objects for improving manufacturing precision and productivity, fin-shaped ribs constituting the parallel flow passes through which a hot medium passes are provided on one side of the flat plate-shaped piece of paper, a required number of laminated pieces of paper, in which a laminated product containing unit members in which the same ribs are arranged on the reverse side at a right angle to the surface are cut to fixed dimensions, are inserted in a mold for casting molding, a two pack thermosetting resin is cast, and an integrated cast molded product is completed.

Effects

According to the configuration of the 1<sup>st</sup> means above, the present invention improves the manufacturing precision by continuous molding /599 in an injection molding mold.

According to the configuration of the 2<sup>nd</sup> means, in the step in which the continuously molded unit members are laminated in the same method as in the above-mentioned means, the step in which the piece of paper cut to prescribed dimensions is inserted is reduced, and by adhering the cut unit members to each other with the resin part, the manufacturing precision of the laminated product is improved.

According to the configuration of the 3<sup>rd</sup> means, an improvement in productivity is planned by reducing the unit member cutting step, adhesive coating step, and lamination step of the 1<sup>st</sup> and 2<sup>nd</sup> means performing integral cast molding in a casting mold.

#### Practical Examples

Since a plastic sheet or thin metal plate can be used in addition to various paper materials and processed paper (same as in the 2<sup>nd</sup> and 3<sup>rd</sup> practical examples), in the former case, a total heat exchanging element, in which not only the exchange of sensible heat (thermo) but of latent heat (moisture) as well is performed, can be manufactured. Moreover, for the synthetic resin used for forming the fins, in the 1<sup>st</sup> and 2<sup>nd</sup> practical examples, a thermoplastic or thermosetting injection moldable resin is provided, and in the 3<sup>rd</sup> practical example, a two-pack cast moldable thermosetting resin is provided.

The 1<sup>st</sup> practical example of the present invention will now be described in reference to Figs. 1 to 3. As shown in the drawings, a rolled plate-shaped

plate 1 is sent to an injection molding mold 3 by a feed roller 2 and subjected to continuous molding by an injection molding machine 4. As shown in Figure, this continuous molded product is a consecutive unit member 12 in which fin-shaped ribs 10 for forming parallel flow passes are molded on one side of the plate-shaped plate 1 and fin-shaped ribs 11 are arranged on the reverse side at a right angle to the surface thereof. The above-mentioned continuous molded product is sent to a cutting step 6 by a guide roller 5 where it is cut to the size of the unit members 12. Next, the upper sides of the fins of the unit members 12 are coated with an adhesive in the adhesive coating step 7, and the finished heat exchanging element 14 product shown in Fig. 3 is obtained in a lamination step 9 via an insertion step 8 in which a separate flat plate-shaped cut plate 1' cut to fixed dimensions is inserted between the unit members 12.

Next, the 2<sup>nd</sup> practical example of the present invention will be described in reference to Figs. 4 to 6. The 2<sup>nd</sup> practical example is a method in which the step for inserting the cut plate 1' cut to fixed dimensions is inserted, and as shown in the drawings, the heights of fin-shaped ribs 10' and 11' on the surface and reverse side of each unit member 12' is made half the height of the ribs forming the parallel flow passes in the 1<sup>st</sup> practical example, then continuously molded in an injection molding mold 3', via the cutting step 6 and adhesive coating step 7, laminated in a lamination step 9' while turning each unit member 12' 90°, and manufacturing a finished product 14' similar to the finished product 14

in the 1<sup>st</sup> practical example. According to the 2<sup>nd</sup> practical example, the required number of pieces of unit members 12' in the injection molding step is twice that of the 1<sup>st</sup> practical example, but the insertion step 8 for the separate cut plate 1' cut to fixed dimensions is reduced, and moreover, in the lamination step, the fin-shaped rib 10' and the fin-shaped rib 10' are adhered, thus improving the adhesive strength as well as the manufacturing precision.

The 3<sup>rd</sup> practical example of the present invention will be described next in reference to Figs. 7 to 10. As shown in the drawings, a slide unit receiver 23 provided with a fin receiving hole 22 inserted in the a mold fin portion 21 is provided opposite the aforesaid movable roll 21 of a slide unit A 20, and a fine receiving hole (not shown) inserted in a mold fin portion 25 is provided opposite the aforesaid mold fin portion 25 of a slide unit B 24 on the other side of this slide unit receiver 23. A hydraulic cylinder A 26 which slides the aforesaid slide unit A 20 and a hydraulic cylinder B 27 which slides the slide unit B 24 on the other side are provided. Moreover, a hydraulic cylinder 29 which slides a protruding pin 28 for releasing the final product from the mold is provided in the aforesaid slide unit B 24. When the slide unit A 20 and slide unit B 24 are retreated (the mold is opened), the cut plate 1" cut to fixed dimensions is inserted between the slide unit A 20 and the mold fin portions 21 and 25 of the slide unit B 24, the slide unit A 20 /600 and the slide unit B 24 are advanced by the hydraulic cylinder A 26 and

hydraulic cylinder B 27, and the entire mold is closed. A two-pack liquid (e.g., urethane) thermosetting resin is subjected to vacuum casting, molded into a laminated state while forming ribs 10" on a flat plate 1" to fabricate a heat exchanging element 15", and after curing, the slide unit A 20 first operates and retreats the hydraulic cylinder A 26, opens the entire mold, and then, a final product is released by means of the protruding pin 28 while the slide unit B 24 operates and retreats the hydraulic cylinder B 27.

According to the method for manufacturing the heat exchanging element of the 1<sup>st</sup> practical example of the present invention in this way, in the manufacturing step for the unit members 12, the fin-shaped ribs 10 provided on the flat plate-shaped plate 1 are subjected to continuous molding in an injection molding mold; hence, the manufacturing precision is improved.

Moreover, according to the method for manufacturing the heat exchanging element of the 2<sup>nd</sup> practical example, the unit members 12' are configured by halving the heights of the fin-shaped ribs 10' and 11' provided on the plate-shaped plate 1 to half the heights in the 1<sup>st</sup> practical example, and joining and laminating the fin-shaped ribs 10' in the same direction; hence, the adhesive strength is improved, and at the same time, the manufacturing precision is improved.

Moreover, according to the method for manufacturing the heat exchanging element in the 3<sup>rd</sup> practical example, the heat exchanging element 15" is molded integrally with the flat plate 1" by molding them in a laminated state while molding the ribs 10' in a casting mold; hence, the unit member

cutting step, the adhesive coating step, and the lamination step in the 1<sup>st</sup> and 2<sup>nd</sup> practical examples are reduced, and productivity is improved.

#### Advantages of the Invention

As evident from the above practical examples, according to the present invention, the unit members and the heat exchanging element are molded in a mold; hence, a highly accurate and highly productive method for manufacturing a heat exchanging element can be provided.

#### 4. Brief Description of the Drawings

Figure 1 is a block diagram showing the heat exchanging element manufacturing line in the 1<sup>st</sup> practical example of the present invention; Figure 2 is a perspective view of the continuous molded product unit members continuously molded in the injection molding step of the 1<sup>st</sup> practical example; Figure 3 is a perspective view of the finished laminated product of the heat exchanging element of the 1<sup>st</sup> practical example; Figure 4 is a block diagram showing the heat exchanging element manufacturing line in the 2<sup>nd</sup> practical example; Figure 5 is a perspective view of a continuous molded product unit member continuously molded in the injection molding step in the 2<sup>nd</sup> practical example; Figure 6 is a perspective view of the finished heat exchanging element laminated product of the 2<sup>nd</sup> practical example; Figure 7 is a perspective view showing the configuration of the casting mold of the 3<sup>rd</sup> practical example; Figures 8 and 9 are cross sections of slide units for the casting mold of the 3<sup>rd</sup> practical example; Figure 10 is a perspective view of the finished heat exchanging element product according to the 3<sup>rd</sup> practical example; Figure 11 is a perspective view showing a conventional heat exchanging element; Figure 12 is a perspective

view of a unit member composing the heat exchanging element in Fig. 11; Figure 13 is a perspective view showing the heat exchanging element according to another conventional practical example; and Figure 14 is a perspective view of a unit member composing the heat exchanging element in Fig. 13.

1: flat plate-shaped plate; 1': cut plate; 3, 3': injection molding molds; 4: injection molding machine; 6: cutting step; 7: adhesive coating step; 8: insertion step; 9, 9': lamination steps; 10, 10': fin-shaped ribs on surface; 11, 11': fin-shaped ribs on reverse side; 12, 12': unit members

- 1: flat plate-shaped plate
- 3: injection molding mold
- 4: injection molding machine
- 6: cutting step
- 7: adhesive coating step
- 8: cut plate insertion step
- 9: lamination step

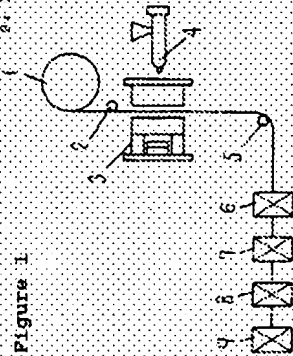


Figure 1

- 10: fin-shaped rib on surface
- 11: fin-shaped rib on reverse
- 12: unit member

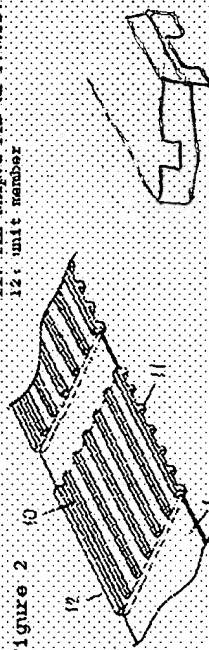


Figure 2

Figure 3

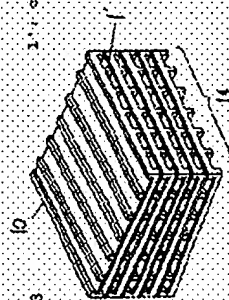


Figure 4

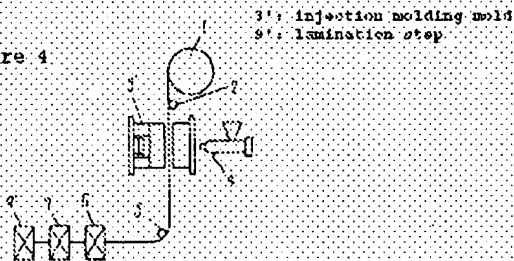


Figure 5

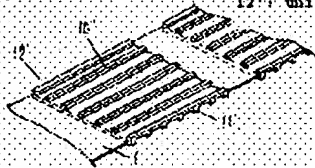


Figure 6

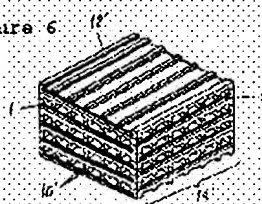


Figure 7

- 20: slide unit A
- 21, 25: mold fin portions
- 22: fin receiver hole
- 23: slide unit receiver block
- 24: slide unit B

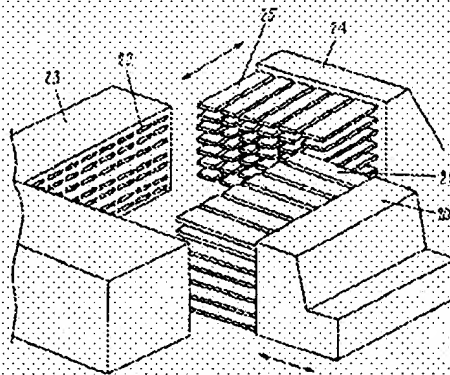


Figure 8

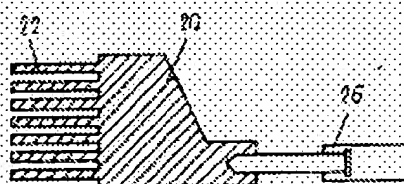


Figure 9

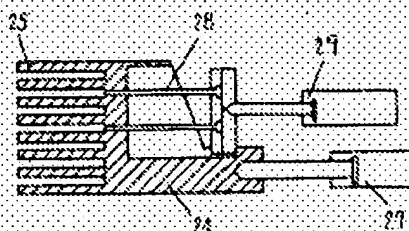


Figure 10

